

# BIOTECHNOLOGY

CIP Code: 51.1201  
Levels: 10 - 12  
Units of Credit: 1  
Prerequisite: Biology or Chemistry  
Skill Certificates: Available

**Description:** Biotechnology is an exploratory course designed to create an awareness of career possibilities in the field of biotechnology. Students are introduced to diagnostic and therapeutic laboratory procedures that support bioscience research and practice.

## Standards, Objectives & Indicators (2007)

**OBJECTIVES and Indicators that are bolded and italicized represent required performance skills. Use the Performance Skills Evaluation Score Sheet to assess.**

### PAST, PRESENT AND FUTURE APPLICATION OF BIOTECHNOLOGY

#### STANDARD 1:

Students will investigate the past, present and future applications of Biotechnology as well as relevant careers.

#### **OBJECTIVES**

- 1.01** Describe historical applications of Biotechnology
- Application - create a timeline of historical biotechnology developments.
  - Method - replicate a historical application of biotechnology.  
(e.g., yogurt, cheese, sauerkraut, bread)
- 1.02** Describe applications of present technology and theorize future implications.
- Application - evaluate the ethical, legal and social implications in biotechnology.
  - Application - describe the technologies that have been developed to identify, diagnose and treat genetic diseases.  
(i.e., gene therapy, genetic testing, genetic counseling, Human Genome Project)
  - ***Method – research and present biotechnology concepts using effective communication skills.***
- 1.03** Identify the scientific fields relevant to biotechnology.
- Application - explain how biotechnology is implemented in various fields.
  - Method - research applications of biotechnology using the Internet, field trips, job fairs, interviews and guest speakers.
- 1.04** Explore the various science and non-science careers associated with biotechnology.
- Method - research through the Internet, field trips, job fairs, interviews and speakers.
  - Method - outline career paths for various occupations in the biotechnology field.

**STANDARD 2:****6% - 4 Questions****Students will exhibit appropriate safety procedures in the laboratory.****OBJECTIVES****02.01** Demonstrate appropriate use of personal protective devices.

- Theory - describe how personal protective devices protect the experiment and the lab worker.
- Application - wear the appropriate personal protective devices.  
(e.g., lab coats, gloves, eye protection)
- Method - demonstrate safe removal of gloves.

**02.02** Maintain a sanitary laboratory environment.

- Theory - explain the appropriate sterilization methods.  
(e.g., steam, chemical UV radiation)
- Theory - identify precautions to prevent contamination of tools, surfaces, self and others.
- **Method - demonstrate proper aseptic/sterilizing techniques.**

**02.03** Exhibit appropriate behavior to protect coworkers and self.

- Theory - explain the dangers of contamination via food, drink, cosmetics, lotion, eye drops and contact lenses.
- Application - take appropriate action when observing hazardous conditions.  
(e.g., chemicals, broken glass, sharps)
- Application - show locations of emergency exits and equipment.  
(e.g., fire extinguishers, blankets, eye washes, showers)

**02.04** Use biotechnology laboratory equipment safely.

- Theory - identify equipment and describe when to use it.
- Method - demonstrate the proper use of biotechnology equipment.

**STANDARD 3:****10% - 7 Questions****Students will follow laboratory procedures properly.****OBJECTIVES****03.01** Exhibit ability to follow laboratory protocols.

- Theory – interpret individual steps within a protocol.
- Method – perform the steps of laboratory protocols accurately and in sequence.

**03.02** Comply with policies and requirements for documentation and record keeping.

- Application - follow standard operating procedures.
- **Method - maintain accurate records and documentation by reporting relevant data in order of occurrence.**

**03.03** Follow appropriate labeling procedures.

- Theory - communicate the rationale for various laboratory-labeling procedures.
- Application - comply with safety signs, symbols and labels.
- Method - practice correct labeling for reagents, specimen samples and reactions.

- 03.04** Implement procedures for handling chemicals.
- Application - identify the hazardous properties of chemicals used in a laboratory setting and their safe use. (flammability, corrosiveness, carcinogenic, etc.)
  - **Method – demonstrate proper use and handling of pipettes.**

## BIO-CHEMISTRY

### STANDARD 04

17% - 12 Questions

**Students will describe the properties of atoms and molecules and prepare lab reagents.**

#### OBJECTIVES

- 04.01** Discuss chemical concepts relevant to biotechnology.  
(i.e., atomic number, atomic mass, valence, isotopes)
- 04.02** Distinguish between covalent, ionic and hydrogen bonds.
- 04.03** Describe the characteristics of bio molecules.  
(i.e., hydrophobic vs. hydrophilic, acidic vs. basic, polar vs. non polar)
- 04.04** Discuss molarity as it relates to solution preparation.
- Theory - explain the concepts of molecular mass, mole and formula weight.
  - Application - use proper units of scientific measurement.
  - Method - calculate the molecular mass of specific molecules.
  - Method - convert mass of molecules to moles and vice versa.
  - Method - calculate the molarity of a solution.
  - **Method - prepare solutions of defined concentrations and pH.**
- 04.05** Relate pH to solution preparation.
- Theory – explain acid base chemistry, pH scale and buffer properties.
  - Method – measure and adjust the pH of specific solutions with commonly used acids and bases.
- 04.06** Relate dilution to solution preparation.
- Theory - explain spectrophotometry and dilution principles.
  - Method - prepare serial dilutions of specific solutions.

### STANDARD 05

7% - 5 Questions

**Students will describe the structure and function of cells and their components.**

#### OBJECTIVES

- 05.01** Identify key cellular components and correlate with function.  
(i.e. nucleus, chromosomes, ribosomes)
- 05.02** Compare and contrast prokaryotic and eukaryotic cells.
- 05.03** Summarize the chromosomal basis for inheritance.
- Theory - characterize normal chromosomes and illustrate the process of meiosis.
  - Theory - explain the consequences of abnormal meiosis. (e.g., trisomy, translocation)
  - Method - perform or simulate a karyotype.

## MICROBIOLOGY

### STANDARD 06

16% - 11 Questions

Students will demonstrate proper bacterial identification and maintenance of cultures.

#### OBJECTIVES

##### **06.01 Prepare bacterial growth media.**

- Theory - compare and contrast bacterial growth requirements for common microorganisms.
- Application - select the appropriate bacterial growth requirements for specific protocols. (i.e. antibiotics, temperatures, selective agents)
- Method - utilize appropriate protocols to prepare several types of bacterial media.

##### **06.02 Inoculate agar and broth media.**

- Theory - explain the different methods of inoculation.
- Application - select the appropriate media and method of inoculation.
- Method - inoculate media using various techniques. (i.e., streak, spread)
- **Method – demonstrate the ability to culture and maintain microorganisms.**

##### **06.03 Identify common categories of bacteria.**

- Theory - explain bacterial properties useful for identification.
- Application - interpret various staining, physiological and morphological characteristics of common types of bacteria.
- Method - perform staining tests to identify bacteria.

### STANDARD 07

34% - 24 Questions

Students will compare and contrast different types of macromolecules and illustrate the flow of genetic information within the cell using the central dogma of molecular biology.

#### OBJECTIVES

##### **07.01 Describe the structure of nucleic acids.**

- Theory - identify the components of the nucleotide.
- Theory - compare and contrast the structure and function of DNA and RNA.
- Theory - describe the structure and function of the types of RNA.
- Application - diagram or construct a model of double stranded DNA.
- Application - explain how the chemical structure of DNA applies to the technique of DNA gel electrophoresis.
- Method – Perform a restriction digest and analyze the results.
- **Method - perform and analyze DNA gel electrophoresis.**

##### **07.02 Describe the structure and function of proteins.**

- Theory - describe the four levels of protein structure.
- Theory - explain the relationship between the structure and function of proteins.
- Theory - identify functional classes of proteins. (i.e., structural, regulatory, enzymes, transport)
- Application - illustrate the primary, secondary, tertiary, and quaternary protein structure.
- Application - discuss ways proteins are used in biotechnology.
- Method - use computer resources to visualize the three dimensional structure of proteins. (protein data bank, Hutch lab, RasMol)

- **Method – demonstrate the ability to use proper separation techniques to differentiate between proteins based on size and structure (chromatography and SDS-PAGE).**
  - Method - explore the effects of environment on the function of enzymes. (i.e., temperature, pH, salt concentration)
- 07.03** Describe how DNA functions as a template for DNA replication.
- Theory - identify the major components and outline the process of DNA replication.
  - Application - explain how DNA replication applies to the amplification of nucleic acids in PCR and DNA sequencing.
  - Method - amplify and analyze DNA using PCR and gel electrophoresis.
  - Method - submit DNA for sequence analysis and interpret results.
- 07.04** Describe protein synthesis.
- Theory - identify the major components, outline the process and describe the products of transcription.
  - Theory - distinguish between transcription in prokaryotic and eukaryotic systems.
  - Theory - identify the major components, outline the process and describe the product of translation.
  - Application - describe the uses of recombinant proteins in biotechnology. (e.g., medicine, agriculture, etc.)
  - Application - explain the relevance of transcription to contemporary technologies such as cDNA libraries, diagnostics and therapies.
  - Method - manipulate the production of recombinant protein in bacteria. (e.g., GFP)
- 07.05** Describe how DNA mutations affect the organism.
- Theory – Characterize the different types of mutations. (e.g., point mutation, frame shift, nonsense, etc.)
  - Theory – Explore the consequences of mutations on the organism (e.g., cancer, genetic disease)

## **STANDARD 08**

**10% - 7 Questions**

**Students will explain recombinant DNA techniques in bacteria.**

### **OBJECTIVES**

- 08.01** Describe the use of plasmids in bacterial transformation.
- Theory - explain the role of restriction enzymes in generating recombinant plasmids.
  - Theory - describe competent cells, transformation and selection methods.
  - **Method - perform a transformation and analyze results.**
- 08.02** Describe the process of plasmid DNA isolation.
- Application - analyze the protocol for isolating plasmid DNA.
  - **Method - purify plasmid DNA and analyze results.**